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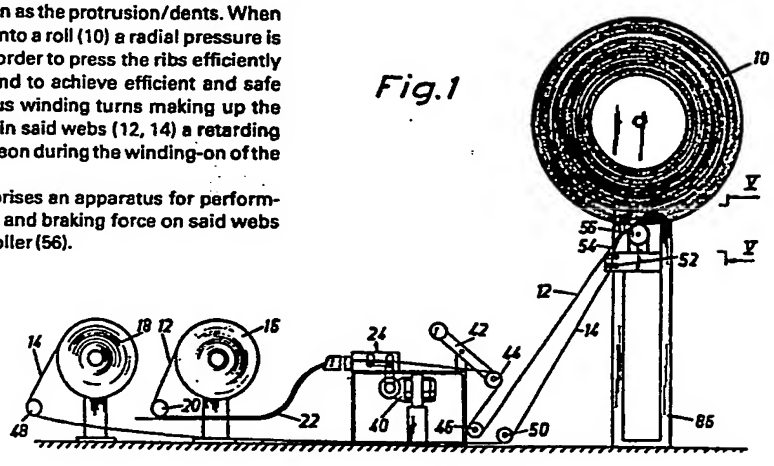
(54) A method and an apparatus for the manufacture of heat exchanger rolls.

(57) A method and an apparatus for the manufacture of heat-exchanger rolls (10). The roll (10) consists of two webs (12, 14) of material which are wound together in superposed relationship. One (12) of the webs is corrugated and formed with protrusions/dents at the crests and bottoms of the corrugations. The second web (14) is provided with lengthwise ribs having the same configuration as the protrusion/dents. When the webs (12, 14) are wound into a roll (10) a radial pressure is exerted on the wheel (10) in order to press the ribs efficiently into the protrusions/dents and to achieve efficient and safe interconnection of the various winding turns making up the roll (10). To impart a tension in said webs (12, 14) a retarding (braking) force is applied thereon during the winding-on of the webs.

The invention also comprises an apparatus for performing the method, the pressure and braking force on said webs being exerted by a pressure roller (56).

Fig.1



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A Method and an Apparatus for the Manufacture of Heat Exchanger Rolls.

The subject invention concerns a method and an apparatus for the manufacture of heat-exchanger rolls comprising two webs which are wound about each other in superposed relationship, one of said webs being corrugated, i.e. formed with crosswise ridges and grooves, and which webs are provided with respectively dents and ribs extending in the lengthwise direction of the webs and preferably having a depth which is less the depth of the ridges and grooves of the corrugations. Both the corrugations and the dents and ribs are imparted to the webs with the aid of rollers which are arranged to engage the respective web while the latter is being supplied to a winding-on station.

The Swedish Patent Application 8008011-2 describes one type of heat-exchanger wheel which is principally different from the heat-exchanger wheels which were in existence up to the advent of the invention described in the Patent Application referred to. Prior-art heat--exchanger rolls or wheels were manufactured by glueing together the various webs of foil making up the roll. The roll in accordance with the Swedish Patent Application referred to, on the other hand, consists of two webs of material which webs are held together in the manner described in the aforegoing, that is, by providing dents and ribs in the two webs and by winding the two webs together in superposed relationship in such a manner that these dents/ribs intermesh and thus immobilise the two webs relative to one another in the axial direction of the wheel. In this manner is obtained a heat-exchanger roll the efficiency of which widely surpasses the

efficiency of heat-exchanger rolls of prior-art types.

The purpose of the subject invention is to show a method and an apparatus devised to manufacture heat--exchanger rolls of the type described above. The method in accordance with the invention is characterised by applying on one of said webs, at the web winding-on station, a pressure which is exerted in the radial direction of the heat-exchanger wheel in order to press the dents formed in said web into the matching ribs formed in the second web and in order to press together the winding turns making up the wheel and applying, during the winding of said two webs into the roll, a braking force on the web which is formed with the lenghtwise ribs.

The apparatus in accordance with the invention comprises a station designed to impart the profile configuration of the first web through rolling, said station designed to impart cross-wise ridges and grooves in said web, said ridges and grooves formed at the crests and bottoms with respective protrusions/dents, a second station designed to impart lengthwise ribs in the second web, and a winding-on station wherein the two webs are wound onto one another in superposed relationship to form the roll. The apparatus is characterised in that means are provided to press the two webs together and to exert a retarding action thereon in order to impart a lengthwise tension in said webs when they are wound into a roll in the winding-on station.

Further characteristics of the invention will become apparent from the dependent claims.

The invention will be described in closer detail in the following with reference to the accompanying drawings, wherein

Fig. 1 is a general lateral view of an apparatus in accordance with the invention,

Fig. 2 is a view of the apparatus as seen from the right with reference to Fig. 1,

Fig. 3 is a partial view from the side of a pair of rollers forming part of the apparatus in accordance with the invention,

Fig. 4 is a cross-sectional view of the same pair of rollers as seen along line IV-IV of Fig. 3,

Fig. 5 is a cross-sectional view on a larger scale along line V-V of Fig. 1 through a pressure roller designed to abut against a heat-exchanger roll manufactured by means of an apparatus in accordance with the invention,

Fig. 6 is a general view of a heat-exchanger roll, and

Fig. 7 is a detail view of a part of the heat--exchanger wheel, showing the principle of the design thereof.

A heat-exchanger roll 10 of the kind described in the introduction hereto consists of two webs of material, preferably of aluminium foil, a first web 12 and a second web 14. At the onset of the manufacturing process the two webs are wound onto supply rolls, denominated respectively 16 and 18.

The first web 12 is supplied from the roll 16 and is carried over a jerks and pressure compensating device 20 and further onto a plate 22 up to a roller station 24. The latter comprises two pairs of rollers, one of which consists of rollers 26 and 28 and is shown in Figs. 3 and 4. These rollers 26, 28 are provided with axially extending flanges 30 and 32, respectively, which are positioned at even pitch spacings across the two rollers 26, 28. The roller 28 is formed with projecting members 36 on the flanges 32 and the roller body proper, these

projecting members 36 serving to shape protrusions/ /dents 34 at respectively the crests and bottoms of the corrugations formed in the web 12. The opposite roller 26 of the pair is formed with matching indents 38 extending peripherally across the cylindrical face of the roller. Before the web 12 arrives up to roller pair 26, 28 corrugations are made therein as the web passes through the nip of a first pair of rollers forming roller station 24. The first pair of rollers is similar to roller pair 26, 28 but has no members corresponding to the projecting members 36 or to the indents 38. The two roller pairs of roller station 24 are driven in mutual synchrony by a motor 40.

The web 12 is carried further to a pendulum means 42 and over a wheel 44 suspended at the end of one of its arms. The pendulum serves to equalize tensile stress in the web 12. The pendulum 42 is provided with a sensing means (not shown but preferably consisting of a potentiometer positioned at the journalling point of the pendulum 42), said sensing means arranged to emit a signal to control the speed of the motor 40.

From the pendulum 42 the web 12 is carried around a fixed deflector wheel 46 and from there to the winding-on station.

The second web 14 of material is wound off the roll 18 and is carried over a pressure or jerk compensating member 48 corresponding to compensating member 20. From the compensating member 48 the web 14 is carried to a deflector roller 50 corresponding to the deflector roller 46 serving web 12. The web 14 is carried further up to a second roller station 52 comprising two pairs of rollers arranged to shape lengthwise ribs into the web 14. For this purpose one of the rollers of the pair is provided with circumferentially extending ridges on its cylinder face whereas the second roller of the pair is

formed with matching grooves. The ribs of the web 14 match the protrusions/dents 34 of the web 12.

The roller station 52 also comprises a sensing means (preferably in the form of a tachometer, not shown), which is arranged to emit controlling signals to the motor 40 to adjust the speed thereof to the advancing speed of the web 14.

The two webs 12 and 14 are wound into the heat--exchanger roll 10. A plate 54 is arranged to guide the web 14 laterally when the web is wound onto the roll 10. The second web 12 abuts against the web 14 and is guided laterally towards the roll 10. A pressure roller 56 provided with beads 57 which are shaped to match the ribs formed in the web 14 is arranged to exert a pressure against the roll 10 during the winding-on operation, which means that each newly wound-on turn of the webs 12, 14 is pressed into the already wound-on turns with the protrusions/dents of web 12 intermeshing with the ribs of web 14. This results in a safe gripping bond between the webs 12, 14 and avoidance of play between the web winding turns. In addition any unevenness is straightened out. In operation, the heat-exchanger wheel will be exposed to stress in its axial direction, such stress being exerted by the air flowing through and against the heat-exchanger roll 10. The ability to take such stress is highly improved by a wheel wherein the winding turns are pressed hard together in accordance with the invention. During winding-on of the roll, the webs 12, 14 are also stretched by the braking action exerted on the pressure roller 56. Stretching of the webs means that the effect of the pressing-together action and of the tension imparted to the webs by means of the pressure roller 56 are permanented and remain in the finished roll 10.

The outermost turns of the wheel 10 are riveted together and/or the wheel 10 is equipped with an external

ring keeping the wheel together and maintaining the tension imparted to the wheel during the winding operation.

The pressure roller 56 is shown in Fig. 5 and consists of a cylindrical body 58 which is rotatably mounted on a shaft 60. The latter is removably but non-rotationally mounted in a frame 62. A brake disc 64 is arranged to be pressed against one of the end walls 66 of the cylindrical body. This is effected with the aid of a bolt 70 which is provided with projecting arms 68 and which is screwed onto threads 72 formed on the shaft 60, whereby the brake shoes 74 of the brake disc 64 are pressed against the cylinder body end wall 66, effecting a braking action on the pressure roller 56. The brake disc 64 is formed with a flange running in a groove 76 formed in the shaft 60, thus preventing the brake disc 64 from being rotated upon braking. The pressure roller 56 is pressed against the roll 10 by a counter-weight 78 (see Fig. 2) to which it is attached by means of a wire 82 carried about a pulley 80 and attached to the frame 62 of the pressure roller. The frame 62 is provided with wheels 84 which are arranged to run along the stand 86 supporting the wheel 10 and controlling the movements of the frame 62.

Figs. 6 and 7 show the general appearance of the heat-exchanger roll 10 and the principle of its structure. Fig. 7 shows a section of the roll 10. For the sake of simplicity, the view of Fig. 7 does not take into consideration the curvature of the roll 10. Fig. 7 shows clearly the provision in web 14 of lengthwise ribs 88 and in web 12 of matching protrusions/dents 34 formed at respectively the ridge crests and the groove bottoms of the corrugations formed in web 12. The interengagement is effected between the protrusions/dents 34 and the ribs 88 during the winding-on of the webs 12, 14 into

the wheel 10. It should be mentioned that the ribs 88 formed in the web 14 are dimensioned to ensure that the relationship between the width at the upper rib edge, the width at the lower rib edge and the rib spacings across the web 14 is approximately 1:2:8.

As appears from Fig. 7 the ridge crests 92 of the corrugations of the web 12 will, upon winding-on of the webs 12, 14, be displaced in the majority of the winding turns in relation to the groove bottoms 94 of the immediately adjacent winding turn of the web 12. When the pressure roller 56 presses the various winding turns together this results in such a deformation of the web 14 that in the manner illustrated in Fig. 7 this web will take on a wavy configuration in its lengthwise extension. This lasting resilient deformation of the web 14 ensures that the two webs are held firmly together during the operation of the wheel 10 and consequently is a further guarantee against separating forces acting axially on the wheel 10.

Experiments made with heat-exchanger rolls manufactured in accordance with the invention show that with suitable choices of the pressures and of the braking force with which the pressure roller 56 acts upon the webs 12, 14 upon their winding-on onto the roll 10, a roll 10 may be obtained having such characteristics that it remains within its elasticity range/area when exposed to the deformation forces that occur during normal operation. When an angle α of 65° is chosen for the corrugations, a pressure of the magnitude of 50N and a braking force of 70N result in a wheel 10 that possesses characteristics that make the wheel fully satisfactory in operation. When larger tensional forces are chosen, further improved operative characteristics are obtained and the elasticity range/area is widened.

The roll 10 is wound onto a shaft 96 serving as a winding core. During the winding-on operation the shaft

is driven by a motor 98 which is connected to the shaft 96 via a gear mechanism 100. The shaft 96 is in the shape of a sleeve and is provided with an internal axially movable shaft 102 the outer end of which projects beyond the sleeve shaft 96 and is formed with threads on which an outer relief disc 104 may be attached. At its opposite end the inner shaft 102 is provided with through-holes or grooves in which is mounted a bar 106, which bar also runs through a groove in the outer shaft 96. The bar 106 is arranged to urge an inner relief disc 108 against the roll 10 in order to clamp the latter in position between the discs 104, 108 during the winding of the roll so that when the wound roll 10 has reached a predetermined size the discs act to relieve the inner winding turns of the roll 10 when further turns are wound thereon. The inner shaft 102 rotates together with the sleeve-shaped shaft 96. The construction comprising an inner, axially movable shaft 102 allows some axial movement of the relief discs 104, 108 relative to the shaft 96, which further increases the clamping effect obtained with the aid of the relief discs 104, 108.

The embodiment of the invention described above is to be regarded merely as an example thereof and a variety of modifications are possible within the scope of the appended claims. For instance, the pressure force by means of which the pressure roller 56 acts on the wheel 10 could be obtained by hydraulic or pneumatic means rather than by a counter-weight 70.

Claims

1. A method of manufacturing heat exchanger rolls (10) comprising two webs (12, 14) which are wound about each other in superposed relationship, one (12) of said webs being corrugated, that is, formed with crosswise ridges and grooves, said webs provided with respectively dents and ribs (34, 88) extending in the lengthwise direction of the webs and preferably having a depth which is less the depth of the ridges and grooves of the corrugations, both said ridges and grooves and said dents and ribs being imparted to said two webs (12, 14) by means of rollers arranged to engage the respective web while the latter is being supplied to a winding-on station, characterised by applying on one of said webs, at the web winding-on station, a pressure which is exerted in the radial direction of the heat-exchanger wheel (10) in order to press the dents formed in said web into the matching ribs formed in the second web and in order to press together the winding turns making up the wheel (10) and applying, during the winding of said two webs (12, 14) into the roll (10), a braking force on the web (14) which is formed with the lengthwise ribs.

2. A method of manufacturing heat-exchanger rolls as claimed in claim 1, characterised in that the braking force is applied on the outermost winding turn of the web (14) which is formed with the lengthwise ribs.

3. An apparatus for performing the method in accordance with claim 1 for the manufacture of a heat-exchanger roll (10), said apparatus comprising a first station (24) for profile rolling the first web (12), said station (24) designed to corrugate the first web to impart crosswise ridges and grooves to said first web, the ridge crests and groove bottoms provided, respectively, with protrusions/dents (34), a second station (52) designed to impart lengthwise ribs (88) in the second web (14), and a winding-on station, wherein the two webs (12, 14) are wound onto one another in superposed relationship to form the roll (10), c h a r a c t e r i s e d i n t h a t means (56) are provided to press the two webs (12, 14) together and to exert a retarding action thereon in order to impart a longitudinal tension in said webs when they are wound into the roll (10) in the winding-on station.

4. An apparatus as claimed in claim 3, c h a r a c t e r i s e d i n t h a t the means for pressing together and retarding the two webs (12, 14) during the winding-on operation is a pressure roller (56) which is provided with beads (57) and arranged to be pressed against the web (14) which is provided with the lengthwise ribs (88) during the winding-on of said web.

5. An apparatus as claimed in claim 4, c h a r a c t e r i s e d i n t h a t the pressure roller (56) having beads thereon is connected with a weight (78) arranged to impart to the pressure roller (56) the force required to press together and retard the webs (12, 14).

6. An apparatus as claimed in any one of claims 3 - 5, c h a r a c t e r i s e d i n t h a t the first roller station (24) wherein the corrugated web is given its configuration, comprises a pair of rollers (26, 28), said rollers provided with axial flanges (30, 32),

in that one (26) of said rollers is provided with grooves or indents (38) and in that the second roller (280) is provided with projecting members (36) by means of which the lengthwise protrusions/dents are formed in the corrugated web (12).

7. An apparatus as claimed in claim 6, c h a r a c t e r i s e d i n t h a t the pair of rollers (26, 28) is driven by a motor (40), said motor arranged to drive said pair of rollers at a certain speed, in that a pressure-equalizing pendulum means (42) is positioned following the roller station (24) as seen in the travelling direction of the web (12), in that said web (12) is arranged to run over a wheel (44) mounted on one arm of the pendulum (42), and that the pendulum (42) is connected to a means sensing the pendulum position and designed to emit a control signal to the motor (40) to adjust the speed thereof.

8. An apparatus as claimed in any one of the preceding claims, c h a r a c t e r i s e d i n t h a t the pressure roller (56) having beads thereon is equipped with a disc brake means (64) to retard the web (14) formed with lengthwise ribs, when said web is being wound onto the roll (10).

9. An apparatus as claimed in any one of claims 3 - 8, c h a r a c t e r i s e d i n t h a t the second roller station (52) is connected to sensing means which in turn are designed to emit a signal to control the speed of the motor (40) to drive the first roller station (24).

10. An apparatus as claimed in any one of claims 3 - 9, c h a r a c t e r i s e d i n t h a t a sleeve-shaped shaft (96) is provided to serve as the core onto which are wound the webs (12, 14) into the roll (10), in that an inner, axially movable shaft (102) is mounted inside said sleeve-shaped shaft (96), that the inner shaft (102) is formed with a threaded end portion which may be pulled

out of the sleeve-shaped shaft (96), that an outer relief disc (104) is arranged to be mounted on said end portion, that the inner shaft is connected with a means (106) arranged to urge an inner relief disc (108) against the roll (10) in such a manner that the latter is clamped between the two relief discs (104, 108) and in that said relief discs are axially movable relative to the sleeve-shaped shaft (96) by means of said inner, axially movable shaft (102).

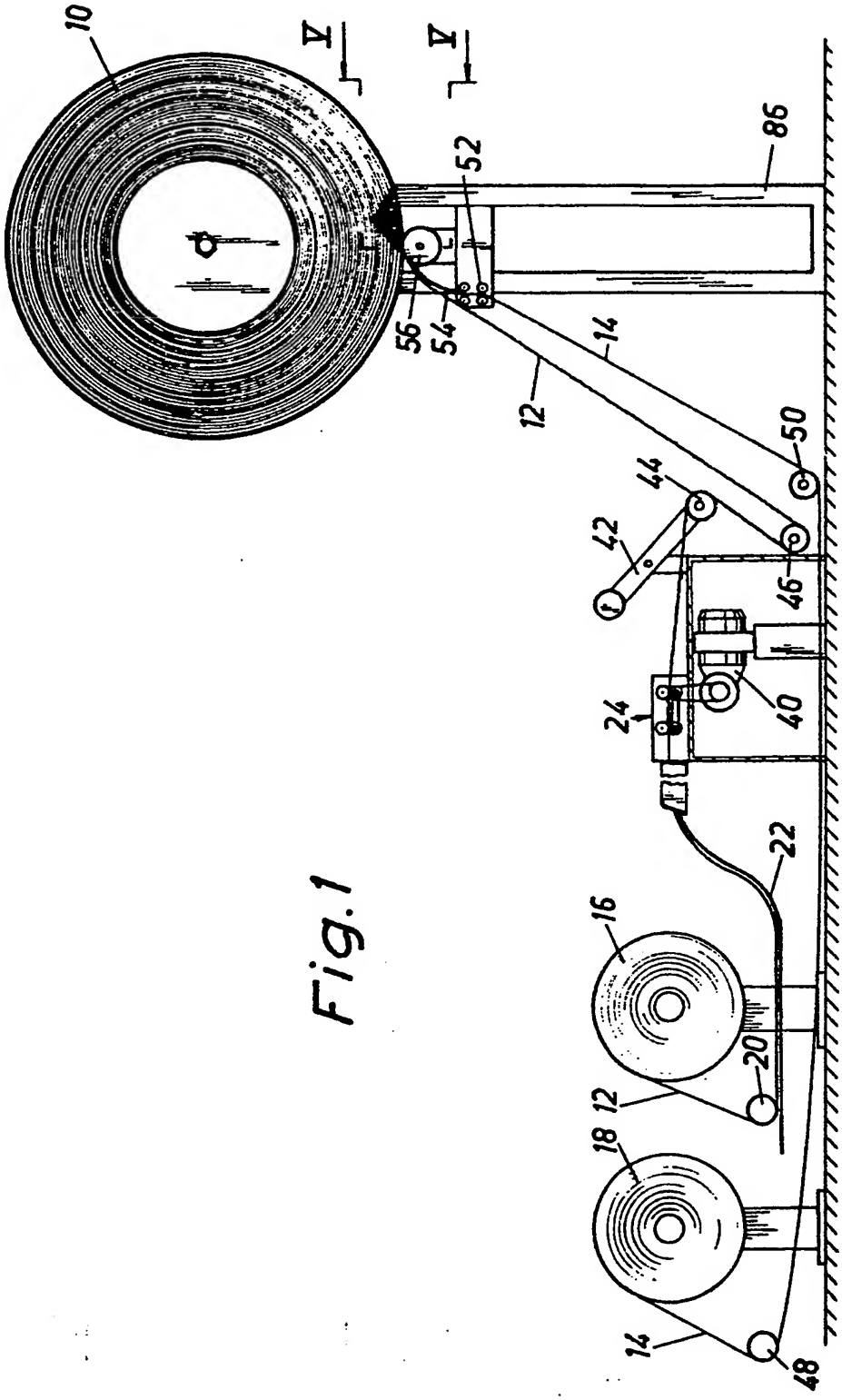
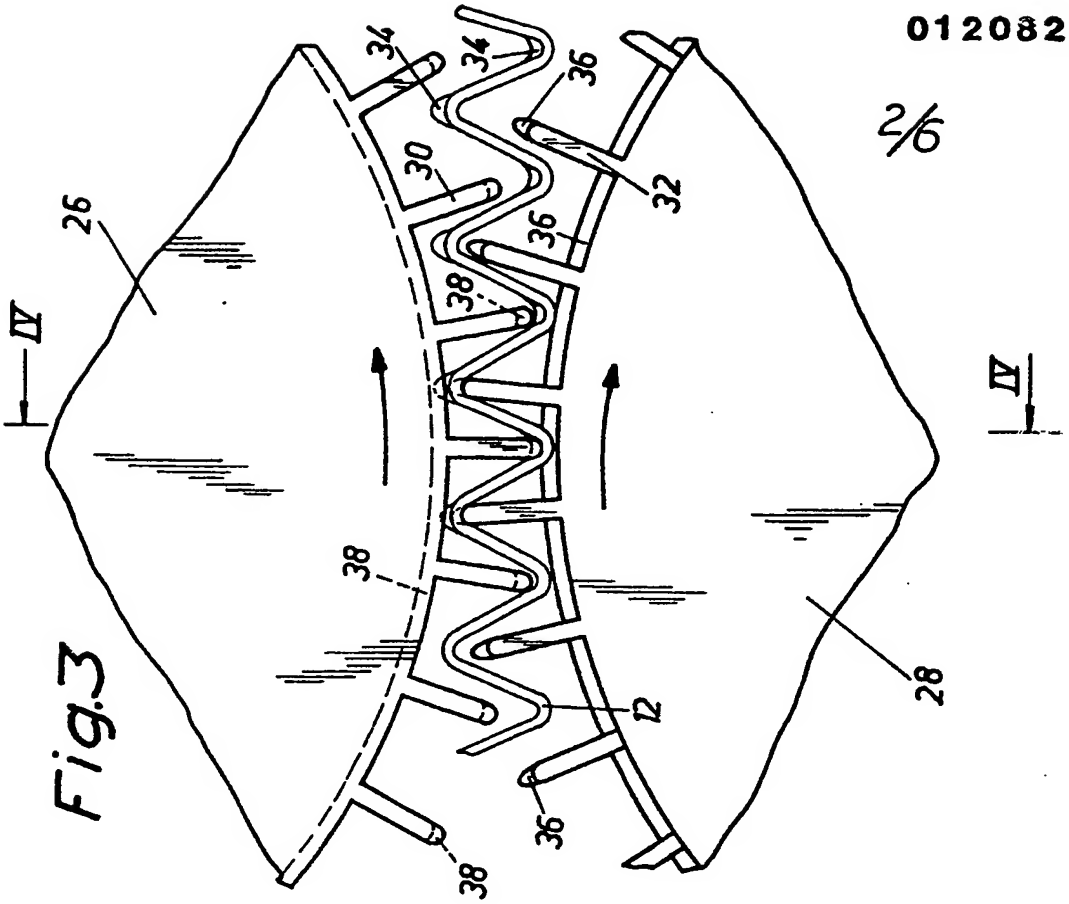


Fig.1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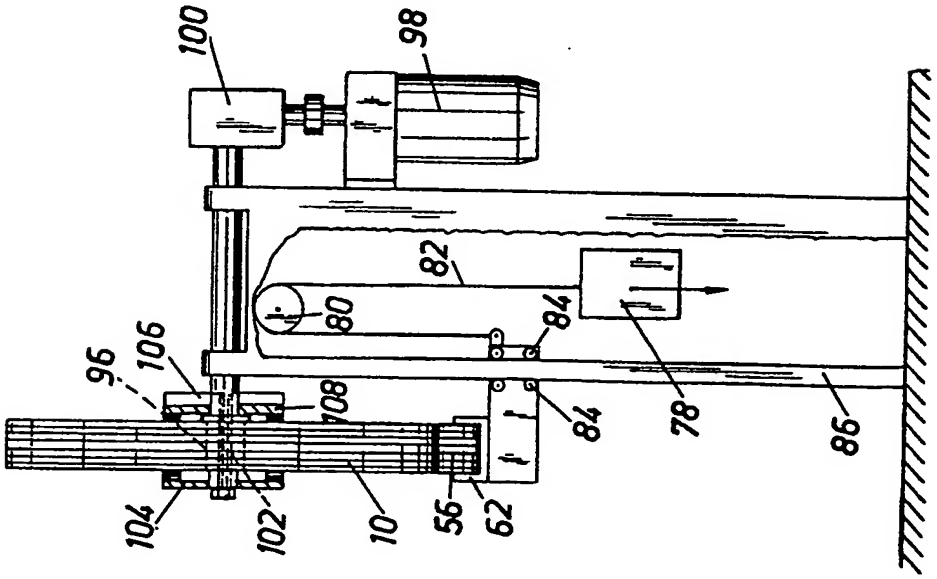
34
36
30
32
36
26
38
IV
IV
38
28
12
36
38

Fig.3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96
106
108
84
78
86
104
102
10
56
62

Fig.2

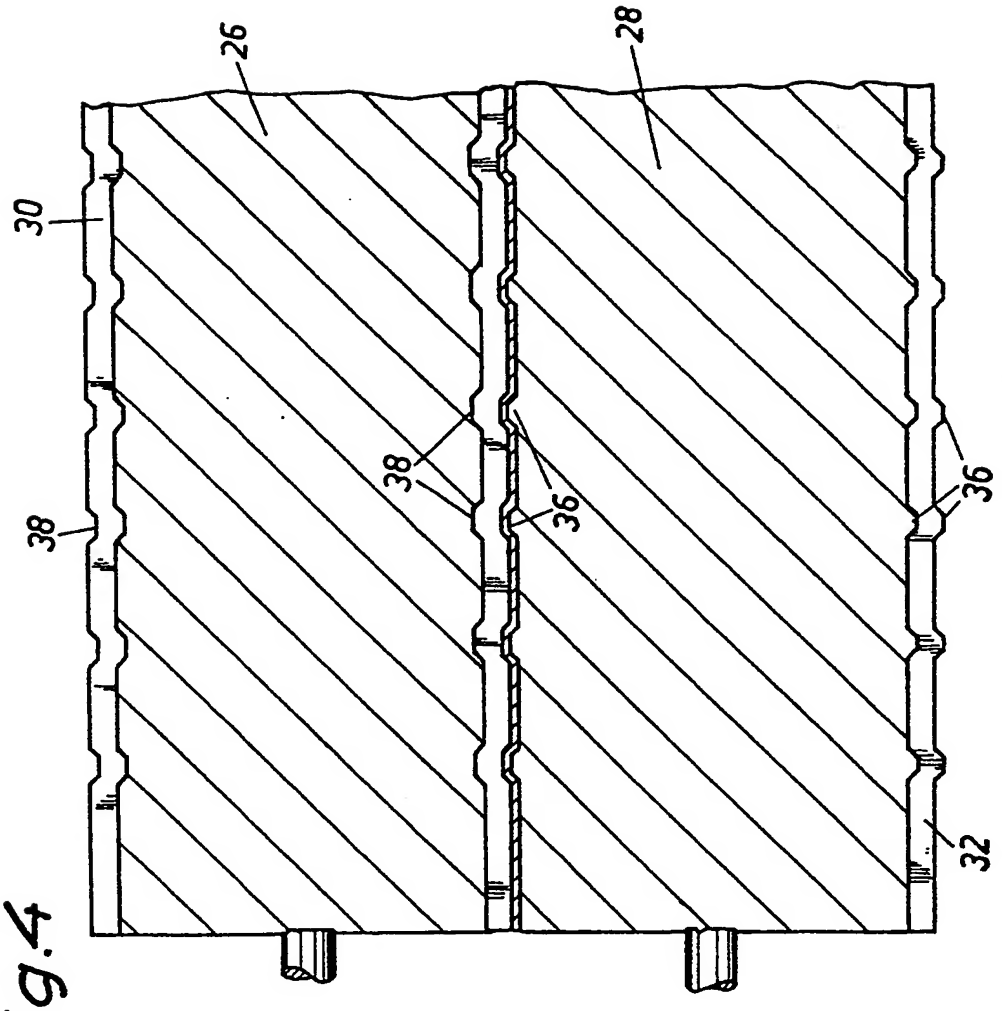
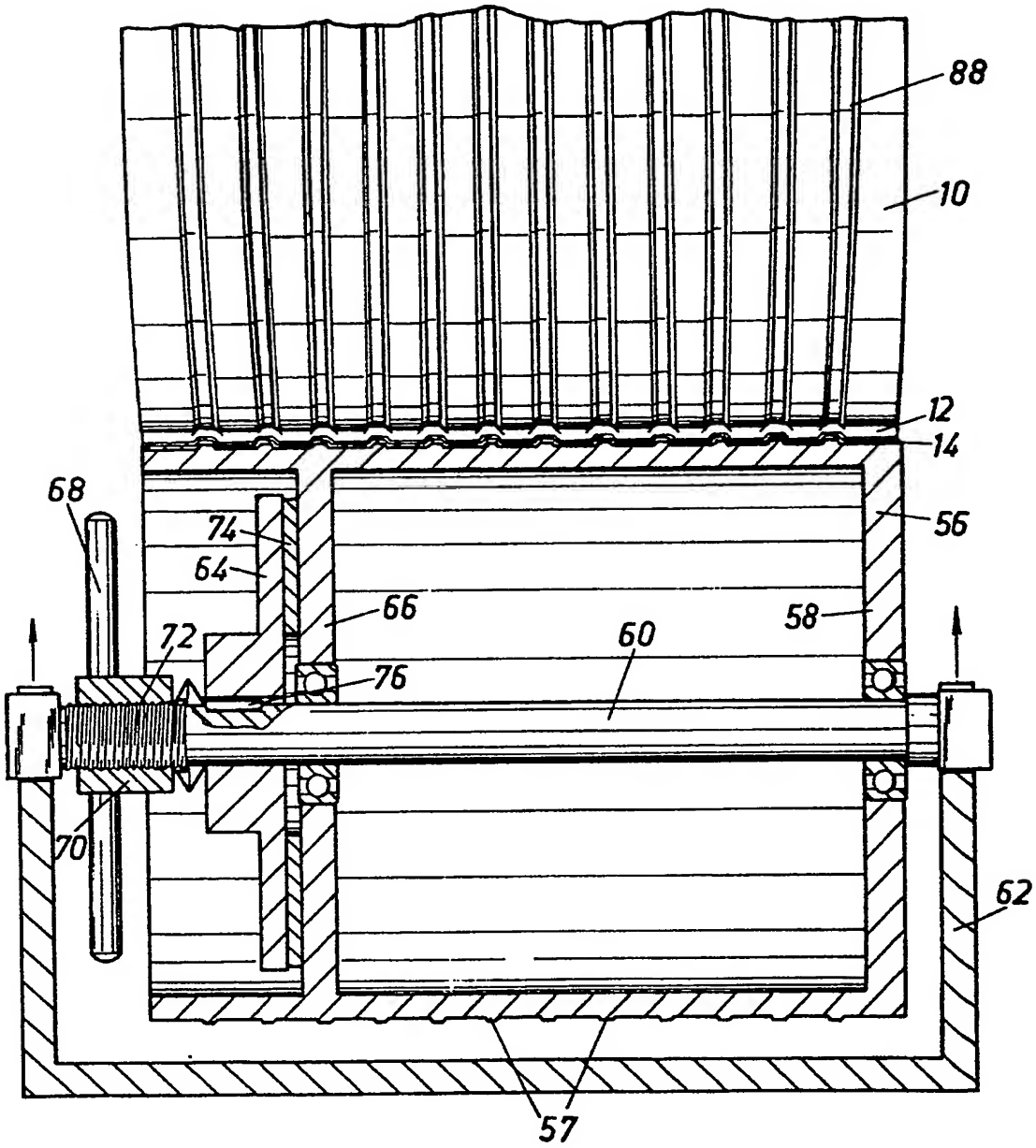


Fig.4

Fig.5



5/6 Fig.6

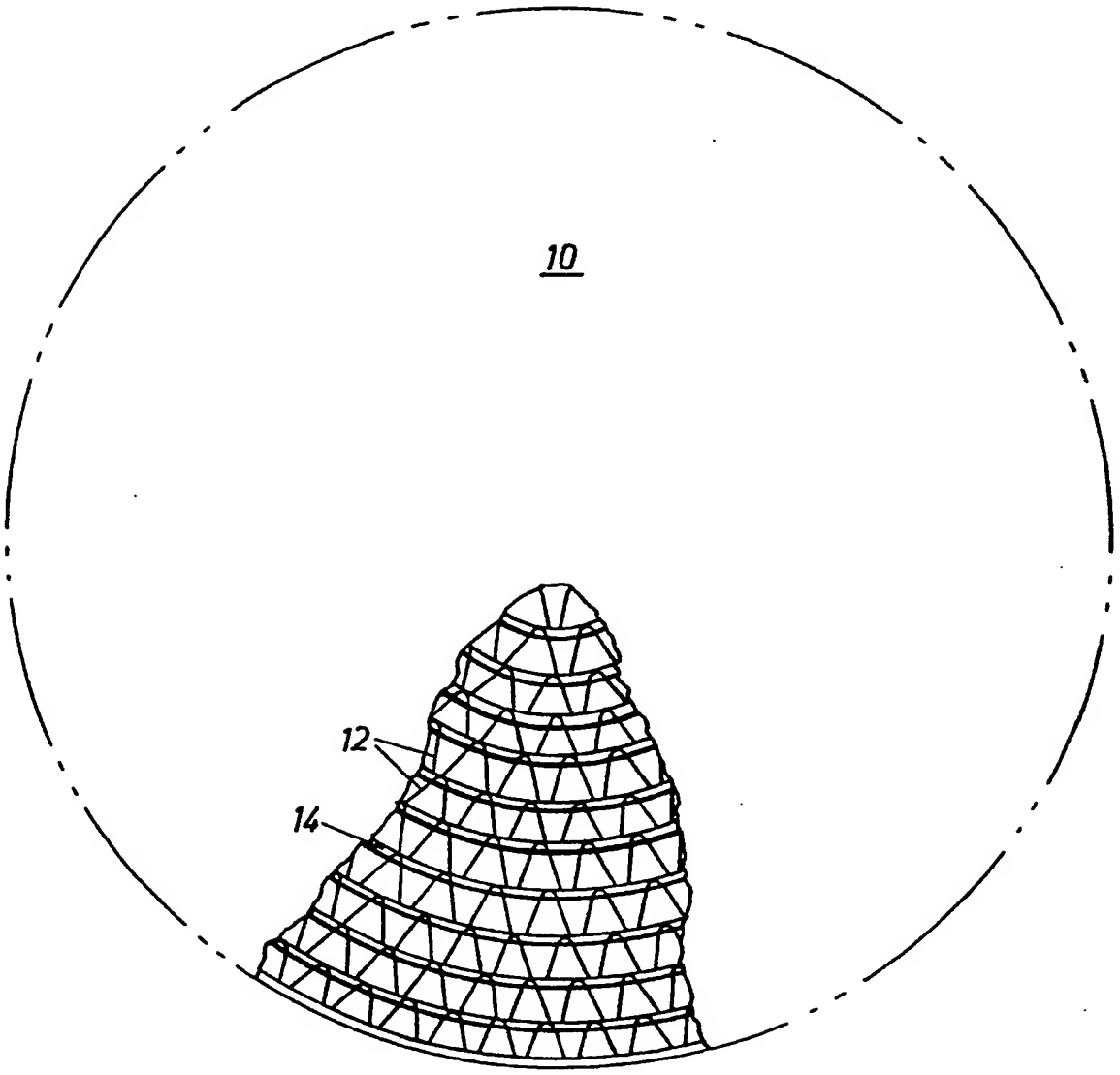


Fig.7